

**Southern California Priority Corridor
Showcase Program Evaluation**

Traffic Signal Integration - Regional Arterial Management System (RAMS) Evaluation Report

FINAL

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Disclaimer

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Abbreviations & Acronyms

AIWS	ATMS Integrated Work Station
ATIS	Advanced Traveler Information System
ATM	Asynchronous Transfer Method
ATMS	Advanced Transportation Management System
ATMSi	Advanced Transportation Management System - Intermodal
Caltrans	California Department of Transportation
CCTV	Closed-circuit Television surveillance camera
CHP	California Highway Patrol
CM	Configuration Management
CMP	Configuration Management Plan
CMS	Changeable Message Sign
CORBA	Common Object Request Broker Architecture
COTS	Commercial Off-the-Shelf
CTC	California Transportation Commission
CVO	Commercial Vehicle Operations
CW	Corridor-wide
CWATIS	Corridor-wide Advanced Traveler Information System Project
CWATMS	Corridor-wide Advanced Transportation Management System Project
CWCVO	Corridor-wide Commercial Vehicle Operations Project
CWSIP	Corridor-wide Systems Integration Project
CWSPP	Corridor-wide Strategic Planning Project
DOIT	Department of Information Technology
DRI	Caltrans, Division of Research & Innovation (formerly NTR)
EAP	Evaluation Activity Plan
EMC	Emergency Management Center
EP	Evaluation Plan
FHWA	Federal Highway Administration
FSR	Feasibility Study Report
FTA	Federal Transit Administration
FTE	Full-Time Equivalent (one full-time employee)
GPRA	Government Performance and Results Act
GUI	Graphical User Interface
HAT	Highway Advisory Telephone service
HP	Hewlett-Packard
HQIT	Headquarters - Information Technology (division of Caltrans)
HTML	Hypertext Mark-up Language
IDL	Interface Definition Language
IPR	Intellectual Property Rights
ISSC	Information Systems Service Center (division of Caltrans)
ISTEA	Intermodal Surface Transportation Efficiency Act (of 1991)
ITS	Intelligent Transportation Systems
LAN	Local Area Network
MOU	Memorandum of Understanding

Abbreviations & Acronyms

MPO	Metropolitan Planning Organization
MTBF	Mean Time Between Failure
MTDB	Metropolitan Transit Development Board
NDA	Non-Disclosure Agreement
NET	National Engineering Technology Corporation
NTCIP	National Transportation Communications for ITS Protocol
NTR	Caltrans Division of New Technology & Research (now DRI)
OCTA	Orange County Transportation Authority
O&M	Operations and Maintenance
OS	Operating system (such as Windows™, Unix, Linux, et. Al.)
PBF	Parsons-Brinkerhoff Farradyne
PC	Personal Computer (Windows™-based)
QUALCOMM	Qualcomm Stadium Authority
RAMS	Regional Arterial Management System
RFP	Request for Proposals
RIWS	Regional Integrated Workstation
RTP	Regional Transportation Plan
RTPA	Regional Transportation Planning Agency
RWS	Remote Workstation
SANDAG	San Diego Association of Governments
SCAG	Southern California Association of Governments
SCAQMD	South Coast Air Quality Management District
SCPCSC	Southern California Priority Corridor Steering Committee
SDPD	San Diego Police Department
SIP	Systems Integration Plan
SOW	Statement of Work
TEA-21	Transportation Equity Act for the 21 st Century
TMC	Transportation Management Center
TOC	Transportation Operations Center
TOSNET	Traffic Operations System Network
USDOT	United States Department of Transportation
VDS	Vehicle Detector Station
VMT	Vehicle Miles Traveled
VOS	Volume/Occupancy/Speed
WAN	Wide Area Network
XML	eXtensible Mark-up Language

Executive Summary

The Showcase Program Background

As required by federal law, all Intelligent Transportation System (ITS) projects that receive federal funding must undergo an evaluation to help assess the costs and benefits of ITS. This document is one of 23 reports produced as part of the Southern California ITS Priority Corridor Showcase Program Evaluation to help planners and decision-makers at the federal, state and local levels make better-informed decisions regarding future ITS deployments. This report presents the experiences, costs, and lessons learned from Southern California's Regional Traffic Signal Integration project. This project is also known locally in the San Diego area as the Regional Arterial Management System (RAMS) project, and will be referred to as such in contributing documents and throughout the remainder of this document.

In 1993, the U.S. Department of Transportation designated Southern California as one of four Priority Corridors in which ITS may have particular benefit. Southern California suffers from extreme traffic congestion, limited room for expanding transportation facilities, and above-average air pollution levels. The Southern California Priority Corridor is one of the most populated, traveled, and visited regions in the country, and consists of four adjoining regions:

- ▶ Los Angeles County and a part of Ventura County
- ▶ Orange County
- ▶ San Diego County
- ▶ Inland Empire (San Bernardino and Riverside Counties).

The ITS Showcase Program is one of several programs that have been implemented in Southern California's Priority Corridor to help aid mobility and mitigate traffic congestion and its associated environmental impacts. The Showcase Program consists of 17 ITS projects that collectively form a corridor-wide intermodal transportation management and information network between Los Angeles, Orange County, San Diego, and the Inland Empire. Each Showcase project deploys a piece of this corridor-wide ITS network, including regional Advanced Traveler Information Systems (ATIS), regional Advanced Transportation Management Systems (ATMS), and regional and interregional communications infrastructure. Eleven of the projects are regional in nature, while the remaining six are corridor-wide.

The RAMS Project Background

The RAMS project is intended to establish a coordinated management system for traffic signals on arterial streets and roadways in the San Diego region. The RAMS project is comprised of two tiers of development. Tier 1, the Regional Traffic Signal Integration Project, was funded by the Southern California Priority Corridor Showcase Program and was managed contractually by the San Diego Association of Governments.

The RAMS project will design and develop a common software application for traffic engineers and signal system managers to coordinate the management of their traffic signal systems with other jurisdictions. This application will be based on an upgrade of existing traffic signal control system software (QuicNet/4) currently in use by many jurisdictions in the San Diego region. Many local agencies have been involved in the planning, design and deployment of RAMS. The system requirements and overall design have been developed cooperatively by a group of agency traffic engineers and signal system operators who also are members of the San Diego Traffic Engineers Council (SANTEC). This council serves as an advisory group for agency transportation engineering issues in the San Diego region. Exhibit 1 below lists the participating agencies or jurisdictions. The agencies shown in bold type will participate in the first round of system deployments for Tier 1.

Exhibit 1 – RAMS Participating Agencies and Cities

Agency or Jurisdiction	Point of Contact
Caltrans District 11	Cindee Feaver
City of Carlsbad ¹	TBD
San Diego Association of Governments (SANDAG)	Richard Chavez (Project Manager)
County of San Diego ¹	TBD
City of Chula Vista¹	Samir Nuhaily/Cecil Chau
City of El Cajon ¹	TBD
City of Encinitas ¹	TBD
City of Escondido ¹	Bruce Grafrath
City of La Mesa ¹	TBD
City of Lemon Grove ¹	TBD
National City ¹	TBD
City of Oceanside ¹	TBD
Port of San Diego ¹	NA
City of Poway ¹	TBD
City of San Diego¹	Minjie Mei/Eddie Flores
City of San Marcos ¹	TBD
City of Solana Beach ¹	TBD
City of Vista ¹	TBD

¹ Represented by SANDAG

The primary project goal is to coordinate traffic signal systems across jurisdictions so that traffic flows are optimized along inter-jurisdictional arterial corridors and roadways. The RAMS project will provide a venue for developing, approving and deploying multi-jurisdictional traffic signal timing plans for inter-jurisdictional arterial corridors. Currently, each jurisdiction (the County, various regional cities, and Caltrans) manages their traffic signals and associated hardware and software independently of other neighboring or regional jurisdictions. RAMS will allow all local agencies the opportunity to coordinate their existing traffic signal management activities through the use of common hardware, software, and data definitions and exchange protocols. Additional information and descriptions of the elements of RAMS architecture, hardware, and software are included in this document in Section 2, *Project/System Technical Description*. Section 3.1, *The Project/System Development Process and Timeline* provides the current task and schedule information for deployment of the system.

The RAMS consists of traffic signal management system software and hardware, the supporting network software, hardware and temporary interconnection between jurisdictions within the San Diego region. The permanent interconnection would be provided by the future Intermodal Transportation Systems Management (IMTMS) regional network project. The RAMS project's two tiers of development – Tier 1 and Tier 2 – are interrelated, but separate, deployment efforts. Tier 1 is an upgrade to existing traffic signal control system software produced by BITran Systems. Tier 2 will be a new software application developed for the San Diego region by National Engineering Technology (NET) Corporation.

RAMS Development and Deployment Concept

Tier 1 includes two phases. The first phase includes limited integration of three agencies: Caltrans District 11, City of San Diego, and the City of Chula Vista. The second phase includes full integration of all agencies using the QuicNet /4+ traffic signal optimization software. Tier 1 includes the implementation of system software at state, county, and city agencies to provide managed and enhanced inter-jurisdictional signal control and coordination functions through a map-based graphical user interface and a Regional Integrated Workstation (RIWS). Agencies are expected to be able to view signal status, controlled time, timing and coordination information, and signals from neighboring agencies. The system will be deployed within a secured network environment. The deployment of Tier 1 is expected to greatly simplify inter-jurisdictional signal coordination along major arterial corridors. The system developer plans to upgrade traffic signal management software called QuicNet/4 to provide the additional functions needed to support traffic coordination across multiple agencies in San Diego County. The upgraded QuicNet/4 has been given a working name of QuicNet/4+ to indicate that it is a QuicNet/4 system with added features and capabilities. This design plans to take advantage of the unique nature of the San Diego Region, where QuicNet is used by all agencies in the region, with exception of the City of Santee. The widespread use of QuicNet is expected to reduce the costs and risks normally encountered in this type of interagency coordination.

Tier 2 is planned to allow agencies to share video, message signs, vehicle sensors, incident, and special event information. Agencies owning field devices will establish levels and conditions of shared control and viewing of field device information. Tier 2 is also expected to provide intermodal information such as transit schedules, status, and arrival information. A combination of local traffic and police departments are expected to use the RIWS in their daily operations.

The Southern California Priority Corridor Showcase Program funded Tier 1 of the RAMS project, but not Tier 2. As a result, under the auspices of the evaluation contract, only Tier 1 will be the focus of these Showcase project evaluation activities.

Evaluation Findings, Conclusions, and Recommendations

The deployment of the RAMS project has experienced numerous delays that have prevented the system from reaching deployment during the period of the evaluation. Although the project has completed only the design and policy development tasks, important lessons learned from these tasks are discussed in this document for the benefit of similar future development efforts. This document contains information and lessons learned relative cost, system planning and design, project schedule, and the influence the Showcase Program integration on the project and regional planning. Expected future benefits of the project, as indicated by project management and project partners, are included in the sections on transportation and traveler information and transportation system impacts. Project delays were primarily attributable to difficulty moving the project forward from planning to deployment, and vendor project management issues.

The RAMS project's primary impacts on other Showcase projects include the continued development of the RIWS, proof of the "Design Once, Deploy Many Times" concept, and integration assistance for the IMTMS network. Other Showcase projects have helped to develop network and network security services for RAMS and other regional projects, based on XML and web service based tools.

The RAMS project is being conducted as a task order contract for \$1,000,000 and is funded through a grant derived from federal, state, and local sources. The project is currently well under budget, but is faced with time constraints due to the delays discussed below. The vendor contract expires in September 2006.

Primary project delays are attributable to the following:

- The project partners and SANDAG had difficulty moving forward from planning to deployment once consensus was achieved on the design of the system
- The project system was based on a sole source for the primary system software. Project management indicated that the project would have benefited from more attentive support by the selected software system vendor and better focus on the project.

- During the period from October 2002 through June 2004 the system developer assigned 4 different project managers to RAMS, requiring continual re-familiarization with the project and project partners.

The RAMS project follows the lead of other regional projects (such as Mission Valley ATMIS) in demonstrating the SCPC Showcase concept of “Design Once, Deploy Many Times.” Additionally, the RAMS project has developed San Diego’s first region-wide cross-jurisdictional signal control system agreements. The success to-date of the consensus on the design of the system can be attributed to time and effort invested by RAMS project participants, which has added considerable and unquantifiable value to the project.

While the RAMS QuicNet/4+ software is proprietary – developed and distributed only by BITran Systems – agreement by project partners to use this software regionally has permitted regional software licensing permits and produced an economy of scale for local agencies participating in the project. Overall the project has great potential to benefit the interagency traffic signal management and improve traffic flows in the region. The project is currently expected to stay on its revised schedule and will benefit from recent tighter project management controls instituted by the system developer.

Based on lessons learned from the RAMS project, mitigation of delays that inhibit project progress may include the following:

- Adoption of a project management standard that includes a structured deliverable document review process. The outcome would be more efficient and expedited deliverable document review cycles.
- Proper workload adjustments for public agency staff responsible for technology project management. Adoption of a project management standard would also allow more accurate estimates of time required to monitor and manage a technology project.
- Agencies must allocate time for project managers to attain an appropriate level of technical expertise with regard to their project’s systems, software, or hardware. Alternatively, agencies could provide the project managers with appropriate support staff that have the applicable technical expertise to support the management of projects of this type. Historically, project managers have not had enough time to come up to speed on their project technologies in addition to conducting their regular project management tasks and deliverable reviews.
- RAMS is a good example of a project that has included the involvement of operations staff throughout the planning and design phases of the project. Operations staff must be included throughout the system development life cycle to ensure system suitability, shorten review cycles, and reduce the potential need for re-engineering system components or redefining system functionality.

- Consensus building, procedure development, and policy formation, are time consuming factors in the design, development, and deployment of regional projects that include multiple agencies and jurisdictions. Subsequent projects in the San Diego will benefit from the regional architecture completion. Groundbreaking consensus building has already occurred with this project, IMTMC/S, Mission Valley Event Management (MVEM), and others. Few previous precedents or models were available for projects of these types; now that the San Diego area has regional, cross-jurisdictional projects that have undertaken these challenges, the policies, procedures, and consensus-building lessons learned should be reemployed in future projects.

1 Introduction

1.1 Purpose and Scope of this Report

As required by federal law¹, all Intelligent Transportation System (ITS) projects that receive federal funding must undergo an evaluation to help assess the costs and benefits of ITS. The information provided in this report is intended to help planners and decision-makers at the federal, state and local levels make better-informed decisions regarding future ITS deployments based on the experiences of Southern California's Regional Arterial Management System (RAMS) project.

This document is one of 23 reports produced as part of the Southern California ITS Priority Corridor Showcase Program Evaluation, and covers only the events and findings resulting from the RAMS evaluation (shown below as the *Traffic Signal Integration Project Report*). The complete findings from the Showcase Program Evaluation are found in the following collection of documents:

Document Type/Title	Date	Document Number
17 Individual Project Evaluation Reports		
Corridor-wide ATIS Project Report	7/16/2003	65A0030/0033
Corridor-wide ATMS Project Report	10/11/2004	65A0030/0049
Corridor-wide CVO Project Report	10/29/2004	65A0030/0051
Corridor-wide Rideshare Project Report	11/1/2004	65A0030/0048
Corridor-wide Strategic Planning Project Report	10/29/2002	65A0030/0028
Fontana-Ontario ATMIS Project Report	11/11/2004	65A0030/0047
IMAJINE Project Report	3/17/2003	65A0030/0029
IMTMC Project Report	11/2/2004	65A0030/0054
InterCAD Project Report	4/2/2003	65A0030/0030
Kernel Project Report	5/30/2003	65A0030/0031
LA ATIS Project Report	7/18/2003	65A0030/0038
Mission Valley ATMIS Project Report	10/13/2004	65A0030/0050
Modeshift Project Report	10/28/2004	65A0030/0052
OCMDI Project Report	2/20/2004	65A0030/0040
Traffic Signal Integration Project Report	11/23/2004	65A0030/0055
Transit Mgt System Project Report	10/19/2004	65A0030/0053
TravelTIP Project Report	6/3/2003	65A0030/0036
5 Cross-Cutting Evaluation Reports		
System Performance Cross-Cutting Report	11/11/2004	65A0030/0056
Costs Cross-Cutting Report	TBD	65A0030/0057
Institutional Issues Cross-Cutting Report	11/15/2004	65A0030/0058
Information Management Cross-Cutting Report	11/18/2004	65A0030/0059
Transportation System Impacts Cross-Cutting Report	11/22/2004	65A0030/0060
Final Summary Evaluation Report		
Showcase Program Evaluation Summary Report	TBD	65A0030/0061

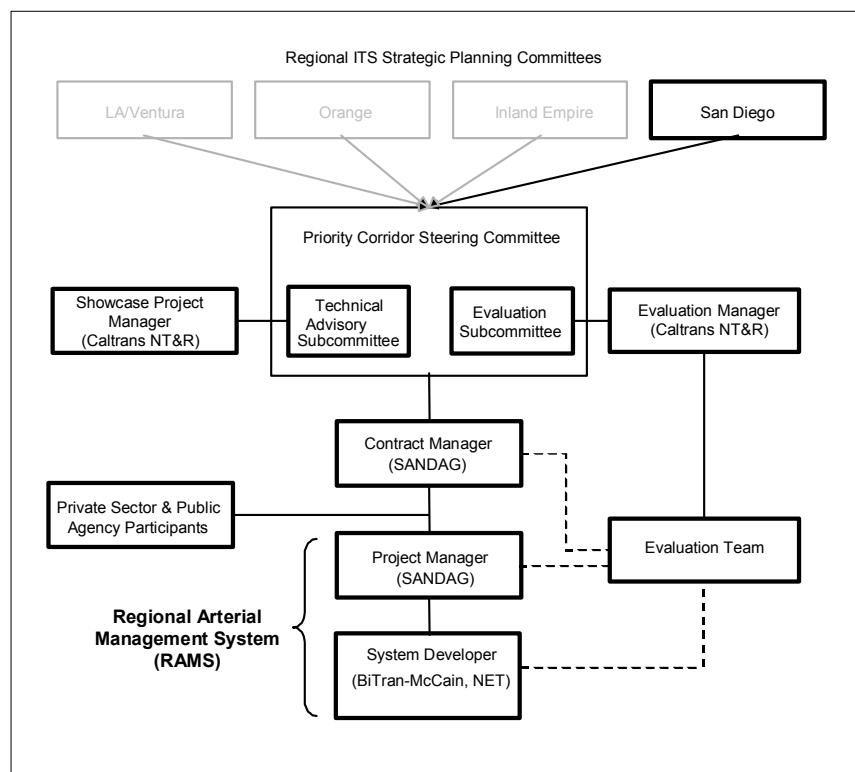
"TBD" indicates a future deliverable that is not yet available.

1.2 Evaluation Design and Approach

The findings outlined in this report are based on five years of personal observations at project meetings, reviews of released project documents and agency memos, and formal and informal interviews and discussions with project partners.

The evaluation is responsive to the needs and suggestions of the Priority Corridor’s Evaluation Subcommittee, which reports to the Priority Corridor’s Steering Committee. As shown in Exhibit 2, both committees are comprised of stakeholders from the federal, state, and local levels.

Exhibit 2 – Management Structure and Organization of the Showcase Program and the RAMS Project



The Steering Committee’s member agencies reflect wide representation from the region in terms of federal and state highway agencies, public safety, cities and counties, transit, air quality and regional planning entities, including:

- ▶ California Highway Patrol (CHP)
- ▶ Caltrans, Division of Traffic Operations (headquarters)*
- ▶ Caltrans, District 7*
- ▶ Caltrans, District 8*
- ▶ Caltrans, District 11*

- ▶ Caltrans, District 12
- ▶ City of Irvine*
- ▶ City of Los Angeles Department of Transportation (LADOT)
- ▶ City of San Diego
- ▶ Federal Highway Administration (FHWA)*
- ▶ Federal Transit Administration (FTA)
- ▶ Los Angeles County Metropolitan Transportation Authority (MTA)
- ▶ Orange County Transportation Authority (OCTA)
- ▶ Riverside County Transportation Commission (RCTC)
- ▶ San Bernardino Association of Governments (SANBAG)
- ▶ San Diego Association of Governments (SANDAG)
- ▶ South Coast Air Quality Management District (SCAQMD)
- ▶ Southern California Association of Governments (SCAG).

* Indicates an Evaluation Subcommittee member

The Showcase Program’s Evaluation Design is based on a set of evaluation Goals and supporting Objectives and Measures that were developed by the Evaluation Team in partnership with federal, state and local stakeholders, and documented in the “Showcase Program Evaluation Approach” in 1998. Each individual Showcase project is evaluated based on an applicable subset of these Goals, Objectives, and Measures in order to help ensure that summary evaluation results can be aggregated from across the multiple Showcase project evaluations. The Showcase Program’s five evaluation Goals include:

- ▶ Evaluate System Performance
- ▶ Evaluate Costs
- ▶ Evaluate Institutional Issues and Impacts
- ▶ Evaluate the Use and Management of Transportation/Traveler Information
- ▶ Evaluate Transportation System Impacts.

As RAMS evolved, project-specific refinements to the evaluation design were documented in a high-level Evaluation Plan (EP) and a detailed Evaluation Activity Plan (EAP). In general, the EP describes the project and/or system under evaluation, and lays the foundation for further evaluation activities by developing consensus among the Evaluation Subcommittee and project partners as to which of Showcase’s evaluation Goals, Objectives, and Measures best apply to the project.

As the project matured, and after the EP had been approved, an EAP was developed to plan, schedule, and describe specific activities (interviews, surveys, etc.) and step-by-step procedures for conducting the evaluation. Data collection began after both plans had been reviewed and subsequently approved by the Evaluation Subcommittee and the project’s partners.

1.3 Organization of this Report

The RAMS Evaluation Report provides a background description of the Southern California Priority Corridor and the transportation challenges facing San Diego County. This is followed by descriptions of the Showcase Program and the RAMS project, including a detailed technical description. The evaluation is subdivided and ordered into the five topic areas described below:

System Performance — provides important benchmark information regarding system availability, reliability, scalability and compatibility. The evaluation quantifies those items and could be used to identify needed improvements and help develop specifications for future systems. The RAMS project was still in the planning and design stages during the period of this evaluation. An evaluation of system performance was not performed for this project. However, important information regarding the system planning and design process and evolution has been included in this section.

Cost — provides important benchmark information regarding funding sources, software licensing, development costs, costs to re-deploy elsewhere or expand the system, and operations and maintenance (O&M) costs. This report includes an estimate of costs to deploy RAMS "from scratch" elsewhere in the State, and also looks at the incremental costs for integrating additional partner agencies. Costs incurred to date include only those associated with the system planning and design process. Deployment costs are estimated and are based on project budgets, and valuations and approximations based on the experience of project partners and system developers.

Institutional Impacts — provides important information regarding the administrative, procedural and legal impacts resulting from the deployment of RAMS. This section will focus on potential changes in operator workloads and responsibilities, as well as changes and limitations of agency-wide policies, procedures and guidelines. This section will focus on the development of the system design as a multi-jurisdictional process and some of the important considerations of similar future deployments.

Transportation & Traveler Information Management — normally provides important benchmark information on system usage and user acceptance (by both agency operators and the general public). During the period of the evaluation, the system remained in the planning and design phase and therefore, transportation and traveler information management impacts could not be measured. Among the recommendations in this report, is to conduct a full evaluation of the final transportation information management capabilities of RAMS once the system is fully deployed.

Transportation System Impacts — normally provides important information regarding systems impacts on transit usage, traffic congestion, air quality, and traffic safety. During the period of this evaluation, the system remained planning and design phase and therefore, transportation system impacts could not be measured. Among the recommendations in this report, is to conduct a full evaluation of system impacts at a future time once the system is fully deployed.

The report concludes with a summary, final remarks and recommendations for next steps. Appendix A contains a blank questionnaire.

1.4 Privacy Considerations

Some of the information acquired in the interview and discussion process could be considered sensitive and has been characterized in this report without attribution. The Evaluation Team has taken precautions to safeguard responses and maintain their confidentiality. Wherever possible, interview responses have been aggregated during analysis such that individual responses have become part of a larger aggregate response. The names of individuals and directly attributable quotes have not been used in this document unless the person has reviewed and expressly consented to its use.

1.5 Constraints & Assumptions

The RAMS evaluation is subject to the following constraints and assumptions:

- ▶ The project's consultant was not required to disclose actual project expenses, so the project's cost was based on the fixed price budget stipulated in the RAMS contract and its amendments. The budget reflects the expenses and costs paid by the client agency, but not necessarily the actual detailed costs for goods and services comprising the project.

1.6 Project Background

1.6.1 The Southern California Priority Corridor

In 1993, the U.S. Department of Transportation designated Southern California as one of four Priority Corridors in which Intelligent Transportation Systems (ITS) could have particular benefit. Southern California suffers from extreme traffic congestion, limited room for expanding transportation facilities, and above-average air pollution levels. The Southern California Priority Corridor, illustrated in Exhibit 3, is one of the most populated, traveled, and visited regions in the country.

Exhibit 3 – The Southern California Priority Corridor and Vicinity



The Southern California Priority Corridor consists of four distinct regions that correspond with the four Southern California Caltrans districts:

- ▶ Los Angeles/Ventura (Caltrans District 7)
- ▶ Orange County (Caltrans District 12)
- ▶ San Diego County (Caltrans District 11)
- ▶ Inland Empire (Caltrans District 8).

Roughly two-thirds of the state's population – about 20 million people – resides in or around the Southern California Priority Corridor.

Exhibit 4 – Population and Number of Registered Vehicles by County

County	Population ² (as of 1/1/2003)	Registered Vehicles ^{3*} (as of 12/31/2002)	Caltrans District
Los Angeles	10 million	6.7 million	7
Orange	3 million	2.2 million	12
San Diego	3 million	2.3 million	11
San Bernardino	1.8 million	1.3 million	8
Riverside	1.7 million	1.2 million	8
Ventura	0.8 million	0.7 million	7
Imperial	0.15 million	0.1 million	11
Total	20.5 million	14.5 million	

*Includes autos, trucks, and motorcycles. Trailers not included.

1.6.2 The Southern California Priority Corridor's ITS Showcase Program

The ITS Showcase Program is one of several programs that have been implemented in Southern California's Priority Corridor to help aid mobility and mitigate traffic congestion and its associated environmental impacts.

Exhibit 5 lists the 17 ITS projects in the Showcase Program. These projects collectively form a corridor-wide intermodal transportation management and information network between Los Angeles, Orange County, San Diego, and the Inland Empire. Eleven of the projects are regional in nature, while the remaining six are corridor-wide in scope.

The RAMS project became one of the 17 projects that comprise the Southern California Priority Corridor ITS Showcase Program. The 17 Showcase projects are listed below by region. Eight of the projects were fast-tracked and designated "Early Start" projects because of their importance as base infrastructure and potential to act as role models for the rest of the Showcase Program. The Showcase funded Tier 1 of the RAMS project. Additional project phases and functionality are planned for the near future and are funded through other sources.

Exhibit 5 – The 17 Showcase Projects and their Status as of September 2004

Project	RFP Issued	Contractor Selected	Contract Executed	Project Underway	Project Complete
Corridor-wide					
Scoping & High Level Design (Kernel)*	✓	✓	✓	✓	✓
Strategic Planning/Systems Integration	✓	✓	✓	✓	✓
CVO					
ATIS	✓	✓	✓	✓	✓
ATMS					
Rideshare	✓	✓	✓	✓	✓
Los Angeles Region					
IMAJINE*	✓	✓	✓	✓	✓
Mode Shift*	✓	✓	✓	✓	✓
LA ATIS	✓	✓	✓	✓	✓
Inland Empire Region					
Fontana-Ontario ATMIS	✓	✓	✓	✓	✓
Orange County Region					
TravelTIP*	✓	✓	✓	✓	✓
OCMDI	✓	✓	✓	✓	✓
San Diego Region					
InterCAD*	✓	✓	✓	✓	✓
Mission Valley Event Management*	✓	✓	✓	✓	✓
IMTMS/C (ATMSi)*	✓	✓	✓	✓	
Traffic Signal Integration (RAMS)	✓	✓	✓	✓	
Transit Management System*	✓	✓	✓	✓	

* Indicates an "Early Start" project.

■ CWCVO and CWATMS do not yet have approved work plans.

2 Project/System Technical Description

High-level Architecture Overview

The RAMS project partners developed a system architecture based on their common use of traffic signal management software produced by BITran Systems, now a division of McCain Traffic Supply. This software, QuicNet/4, is currently in widespread use by the cities and transportation management agencies in the region, thus allowing the system developer to easily integrate the jurisdictions onto a common network using the same management software. RAMS Tier 1 will use QuicNet/4+, an upgraded version of the QuicNet/4 software.

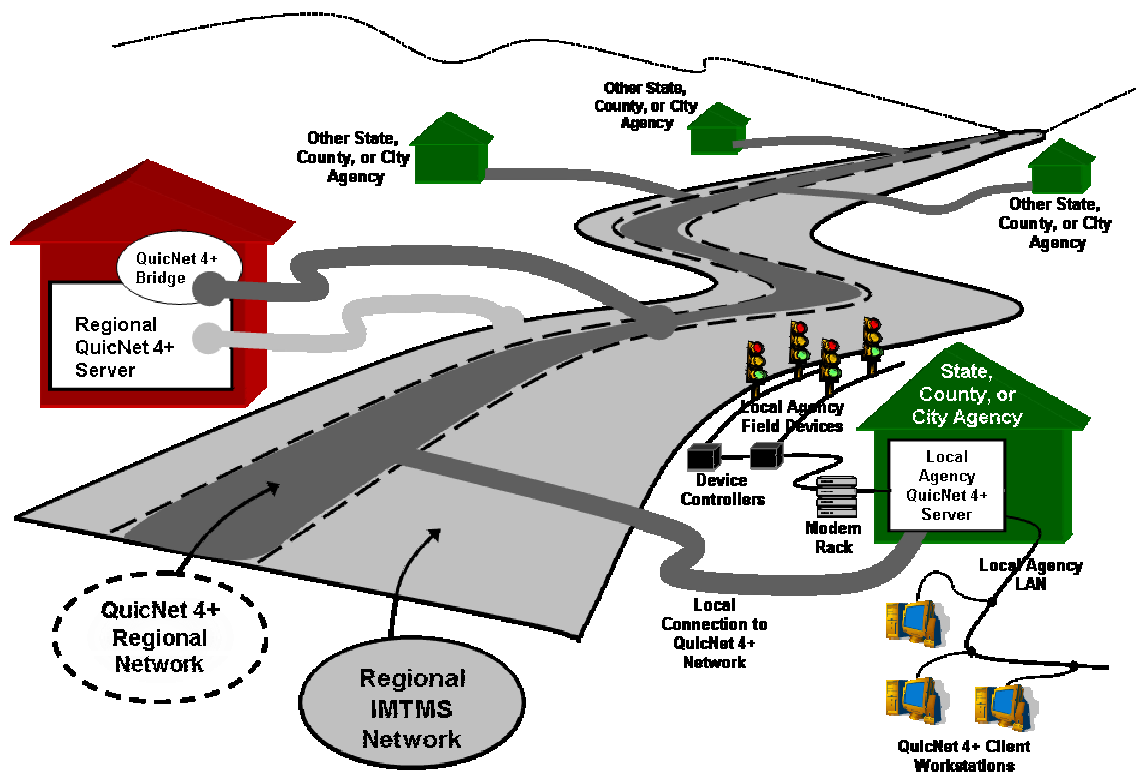
The RAMS Tier 1 system and QuicNet/4+ architecture will be based on the QuicNet/4 logical and functional architecture. QuicNet/4+ will upgrade the existing capabilities of QuicNet/4 to provide the required distributed traffic signal control and coordination system. An important component of this distributed system will be location transparency for supported devices. Location transparency means that the client software does not need to know whether a device is located on the local network or on a remote network in order to perform the various communications and management functions. Functions for security and for regional timing plans will also be fully distributed. Workstation or client requests for information about a field device will be sent to the local agency QuicNet/4+ server.

The QuicNet 4+ server will:

- Control a local agency's client workstation permission to view device information,
- Determine where device information is located,
- Retrieve device information, either locally or remotely,
- Return device information to the client workstation,
- Display device information to the user of the client workstation,
- Validate and constrain field device control based on client workstation permissions defined on the QuicNet 4+ server.

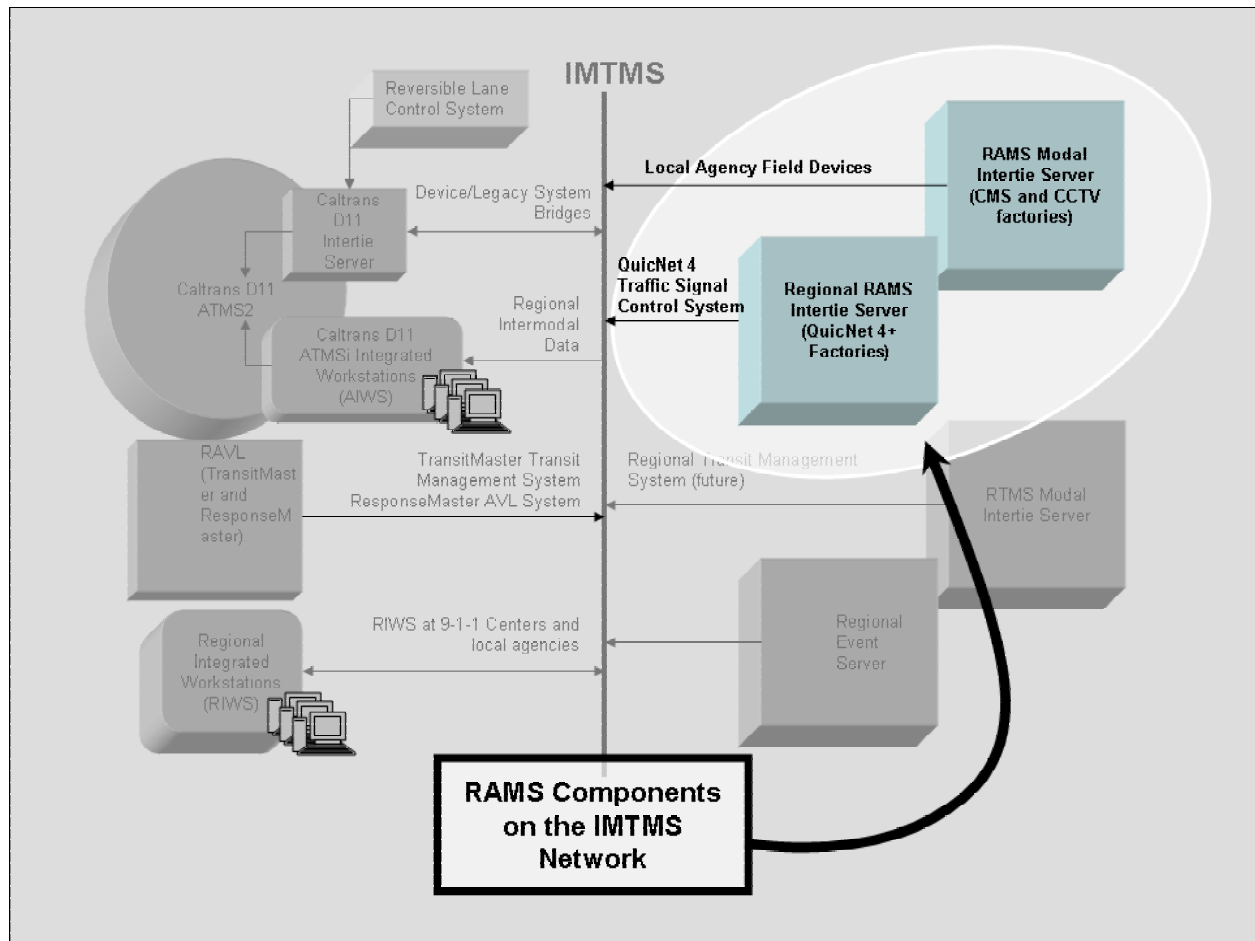
A simplified depiction of the RAMS architecture, including the servers, clients, the regional QuicNet/4+ network, and the relationship to the regional IMTMS network, is shown in Exhibit 6.

Exhibit 6 – Simplified Illustration of the RAMS QuicNet/4+ Architecture



Agencies participating in regional traffic signal management will share data via a secured QuicNet/4+ Network. The QuicNet/4+ network will use a T1 leased line provided by SBC Communications. In the future, RAMS components may use the regional network to exchange data and information with other regional intermodal and transportation management centers. RAMS components on the IMTMS network (the regional network in San Diego) are depicted in Exhibit 7.

Exhibit 7 – Simplified Overview of RAMS Components on the IMTMS Network



The QuicNet/4+ is distributed control system with a map-based GUI using a Windows 2003 operating system and Microsoft Active Directories to support security requirements. The software interface allows an agency traffic engineer to enter traffic signal system configuration data, review and update timing plans, download plans to controllers or groups of controllers, upload plans in controllers to a distributed database, and monitor system operations in near real time. The QuicNet 4 software has always been a distributed system; the QuicNet/4+ upgrades this capability to multiple agencies.

RAMS System Configuration Summary

The RAMS Project has implemented a traffic management system that includes the following hardware, software, network, and field device components.

System Component	Component Description and Function
<ul style="list-style-type: none">▪ <i>Communications and Applications Server(s)</i>	<p>The communications and applications server functions may be physically located on a single computer or may be separate computers. The server(s) will be used for communications and database management (there may be multiple servers in larger installations). QuicNet 4 uses a Windows 2003 operating system environment and interfaces with a variety of relational databases. The San Diego region will be using the Microsoft SQL Server Relational Database Management System (RDBMS). The relational database is used to maintain system configuration data, local controller timing plans, and real time data gathered from the field, including system detector and controller information. Real time data is accumulated to produce a variety of reports on system operation and traffic conditions.</p>
<ul style="list-style-type: none">▪ <i>Operator Workstations</i>	<p>Operator workstations with QuicNet/4+ will also be a PC based systems and use a Windows 2003 operating system. The number of workstations installed will depend on the size of the operations center.</p>
<ul style="list-style-type: none">▪ <i>Local Area Network (LAN)</i>	<p>A local area network will be used to connect the servers and the operator workstations. The LAN may be dedicated to QuicNet/4+ operations or part of a wider area jurisdiction-operated LAN. Exhibit 4 illustrates the configuration of the LAN within the network structure.</p>
<ul style="list-style-type: none">▪ <i>RAMS Sub-network and the Regional IMTMS Network</i>	<p>All RAMS agencies are connected on a sub-network (also a leased service facility with potentially a different network protocol than IMTMS) through the QuicNet/4+ Front End Processors – one site, located at the Regional Caltrans/CHP TMC, will have a QuicNet/4 Interface that will act as a gateway to the IMTMS Network by connecting via a single router to the IMTMS network. This alternative does not support the Showcase architecture and may only be useable during the Tier 1 portion of RAMS.</p> <p>Alternatively, agencies with a RIWS can integrate to the IMTMS network through a router that connects to a leased service provider network system – the router is configured with the appropriate IMTMS leased service protocol.</p>

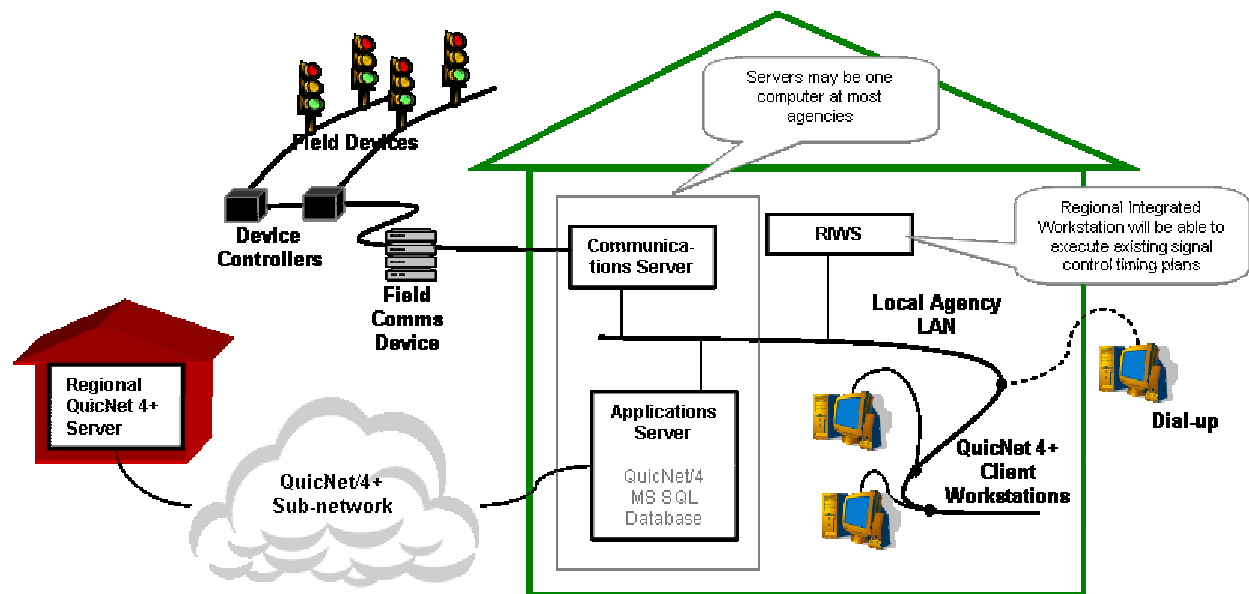
Workstation/Server Architecture

The RAMS project uses client-server architecture within each agency connected by a LAN. The local agency LAN will allow the QuicNet/4+ client workstation to access the QuicNet/4+ local agency server to obtain information about connected field devices and events occurring on the traffic management system.

The local agency QuicNet/4+ server provides clients with controlled access to both local and remote agency devices and is deployed on a Windows 2003 Active Directories server application to provide security. The local agency QuicNet/4+ server accesses the QuicNet4+ regional network to obtain information about devices located at other remote agencies.

QuicNet/4+ will provide an agency-to-agency interface (also called a center-to-center interface) based on NTCIP standards and/or other integration approaches for the IMTMS network. This interface, which will be standardized around XML, will support functions that interact between RAMS Tier 1 (i.e., traffic signals) and Tier 2 (i.e., other field devices) systems. Exhibit 8 illustrates the configuration of the local agency QuicNet/4+ architecture.

Exhibit 8 – Detail of local agency QuicNet/4+ Architecture



3 System Performance Evaluation

The deployment of Tier 1 of the RAMS project has experienced numerous delays that have prevented the system from reaching deployment during the period of the evaluation. As part of the system performance evaluation, a review of the project and system development process, history, and development timeline are examined.

Although the project has completed only the design and policy development tasks, important lessons learned from these tasks are discussed in this section for the benefit of similar future development efforts. Therefore, this section contains information and lessons learned relative only to the system planning and design, project schedule, and the influence the Showcase Program integration on the project and regional planning.

3.1 The Project/System Development Process and Timeline

Tier 1 of the RAMS project is a two-phase development and deployment effort. Tier 1 of the project was the only part funded through the Showcase Program. The contract for Tier 1 was issued as a Task Order contract through the San Diego Association of Governments (SANDAG) to BITran Systems, Inc. on October 1, 2002. The total contract value is \$1,000,000. All contract management activities are the responsibility of SANDAG. Project technical management is being led by SANDAG in cooperation with the participating cities, Caltrans District 11, and the County of San Diego.

The RAMS project was originally conceived and included as part of the San Diego Regional Intelligent Transportation Strategic Plan of 1996. Project kick-off took place in 1998. The project has been 8 years in planning and development as of the writing of this document.

The original contract tasks (dated September 6, 2001) have changed to accommodate changes in schedule and scope. The new contract tasks (revised as of August 20, 2004) have combined some the original project tasks into a single work order. The table in Exhibit 9 maps the original contract tasks to the revised tasks.

Exhibit 9 –RAMS Tier 1 Project Task Revisions

Original Task No.	Original Task Description	Original Sub-task No.	Changes, Revised Task Description, and Status
1.1	Establish QN4 development baseline	RAMST 1.1.1 RAMST 1.1.2 RAMST 1.1.3 RAMST 1.1.4	Task Completed 10 March 2003 Document: RAMST 1.1.4 Final
1.2	Preliminary design for Tier 1	RAMST 1.2.1 RAMST 1.2.2 RAMST 1.2.3 RAMST 1.2.4 RAMST 1.2.5	Task Completed 15 Oct 2003 Document: RAMST 1.2.4 Final Deleted deliverable 1.2.5
1.3	Build prototype Tier 1	RAMST 1.3.1 RAMST 1.3.2	Task Deleted. Merged and distributed into new work items 1.3 thru 1.6.
1.4	Detailed design for Tier 1	RAMST 1.4.1 RAMST 1.4.2 RAMST 1.4.3	Tasks 1. 4 through 1.7 have been divided into 4 phases, new Tasks 1.3 thru 1.6
1.5	Complete software development Tier 1	RAMST 1.5.1 RAMST 1.5.2	
1.6	Model deployment (3 agencies)	RAMST 1.6.1	
1.7	Test operational configuration	RAMST 1.7.1 RAMST 1.7.2	
1.8	Complete Tier 1 deployments	RAMST 1.8.1	Original Task becomes Task 1.7
1.9	Training, documentation	RAMST 1.9.1 RAMST 1.9.2	Original Task becomes Task 1.8
1.10	On-going maintenance & support	RAMST 1.10.1 RAMST 1.10.2	Original Task becomes 1.9, added QuicNet/4+ licensing
1.11	Continuing configuration management, Support RAMS IDL	RAMST 1.11.1	Original Task merged with individual tasks as “attend review and status meetings”
1.12	Support Tier 2	RAMST 1.12.1	Original Task merged with individual tasks as “attend review and status meetings”

The revised RAMS Tier 1 tasks are described in the following paragraphs (paraphrased from the contract task descriptions) and will be delivered under a series of work orders. The Tasks are numbered to indicate a Tier 1 level task and a work order or work item number. (e.g., Task 1.2 indicates Tier 1 Work Item 2)

Task 1.1 – Establish QuicNet 4+ High Level Design

Describes the current functionality of QuicNet 4 software and firmware and to establish a development baseline for QuicNet 4+ functionality. The results will be used as an input to complete development of Functional Requirements for RAMS. A draft and final high-level design document will be produced.

Task 1.2 – Final Design and Functional Requirements

Develops the final design and functional requirements of the required modifications to upgrade QuicNet 4 to QuicNet 4+, and meet the established Tier 1 functional requirements. The preliminary design will focus on proposed QuicNet 4+ functionality such as WAN communications, modified database structures, GUI interface guidelines, security functions, system-to-system interfaces, and Showcase Program compliance. As part of the preliminary design process, the Contractor will make a technical, schedule and cost risk assessment of the Showcase integration option discussed earlier. Based on this assessment, the Best Estimate Cost Proposal (submitted to SANDAG prior to contract execution) will be modified as necessary to establish a Firm Fixed Price proposal to complete the remaining work items.

Task 1.3 - Phase 1 System Deployment – Security Features

Phase 1 of the Tier 1 system includes an initial deployment of the RAMS Tier 1 project at three agencies: Caltrans District 11 TMC, City of San Diego, and City of Chula Vista. This deployment is not intended to be a fully functional system, but to provide a demonstration and proof of concept for the security features. This phase of the system development will concentrate on building the security framework and applying the sharing of controller timing plans between agencies.

Task 1.4 - Phase 2 System Deployment – Monitoring Capabilities

Phase 2 builds on the functionality of Phase 1 by adding the capability to view and monitor the status of controllers across agency boundaries. This work order includes redeployment of the modified system at the original three sites deployed in Phase 1, Work Item 3.

Task 1.5 - Phase 3 System Deployment – Corridor Timing Plans

Phase 3 adds regional GIS support and regional scheduling to the system, and includes redeployment at the original three agencies.

Task 1.6 - Phase 4 System Deployment – Center to Center Interface

Phase 4 adds the center-to-center interface between Tier 1 and Tier 2 delivered by NET as part of another contract. This work item will develop the QuicNet side (Tier 1) of this interface and includes any redeployment at the original three agencies as a result of providing the center-to-center interface. Installation of the regional QuicNet/4+ server is planned for this phase.

Task 1.7 - Final System Deployment of Tier 1 – Expansion to All Agencies

Deployment of QuicNet/4+ to the remainder of the agencies as they complete QuicNet/4 installations and required preparations for QuicNet/4+. Each agency brought on-line to the regional IMTMS Network will be added to the QuicNet/4+ regional license. Each agency added to the Regional IMTMS Network will be acceptance tested. The cost of deployment will be based on the level of installation support and hardware required. There are three levels of installation. Level 1 includes an agency server and two workstations and up to 5 days of installation setup and initial support. Level 2 includes an agency server and one workstation and up to 5 days of installation setup and initial support. Level 3 includes an agency server and one workstation and up to three days of setup and initial support. In all cases, it is required that the individual agency has an operational QuicNet/4 in place before the upgrade to QuicNet/4+ begins.

Task 1.8 - Training and Documentation

BITran will modify the standard QuicNet/4 manual set to reflect operational, technical and maintenance changes necessary to operate the QuicNet/4+ product. Identified training will be provided at the BITran/McCain Vista facilities. Three day training sessions will be scheduled for groups of regional agency traffic management personal. BITran will provide the training three sessions in an effort to allow various personal to attend one of the training sessions. Training vouchers will be provided to SANDAG for any training not undertaken prior to contract completion, which will allow SANDAG to act on future training opportunities at no additional charge within the limits of the vouchers.

Task 1.9 – Maintenance, Support and License

The regional license will cover Caltrans District 11 and all member local agencies in SANDAG. This license is viewed as licensing of addition functionality of QuicNet/4 + and does not replace the need for a QuicNet/4 license. Included in the above work is maintenance and support. BITran will provide system maintenance support to the Region for the duration of the contract (ending September 30, 2006). The first year support will be for 4 staff days per month and thee second year will be 2 staff days per month. System maintenance will include support of the QuicNet/4 + hardware and software and for related operational use support as may be required. Support will not include Regional IMTMS Network maintenance support.

Exhibit 10 – Original and Revised RAMS Tier 1 Project Schedule

Task	Description	Original Schedule/Completion	Revised Schedule/Completion
1.1	Establish QuicNet 4+ High Level Design	Mar 2003	Apr 2003
1.2	Final Design and Functional Requirements	May 2003	Oct 2003
1.3	Phase 1 System Deployment – Security Features	May 2003 – Oct 2003	Jun 2004 – Mar 2005
1.4	Phase 2 System Deployment – Monitoring Capabilities	May 2003 – Oct 2003	Feb 2005 – Aug 2005
1.5	Phase 3 System Deployment – Corridor Timing Plans	May 2003 – Feb 2004	Aug 2005 – Mar 2006
1.6	Phase 4 System Deployment – Center to Center Interface	Unscheduled	Aug 2005 – May 2006
1.7	Final System Deployment of Tier 1 – Expansion to All Agencies	Mar 2004 – Dec 2004	Mar 2005 – May 2006
1.8	Training and Documentation	Unscheduled	Mar 2006 – Aug 2006
1.9	Maintenance, Support and License	Unscheduled	May 2006 – Sep 2006

Project delays are primarily attributable to the following:

- The project partners and SANDAG had difficulty moving forward from planning to deployment once consensus was achieved on the design of the system
- The project system was based on a sole source for the primary system software. Project management indicated that the project would have benefited from more attentive support by the selected software system vendor and better focus on the project.
- During the period from October 2002 through June 2004 the system developer assigned 4 different project managers to RAMS, requiring continual re-familiarization with the project and project partners.

The prime contract for the development of the RAMS system was issued to BITran – McCain in October 2002. Some of the RAMS design and development tasks associated with this project are being conducted concurrently through the IMTMS project (another Showcase funded project in the San Diego region primarily responsible for integration of all advanced transportation management systems to the regional IMTMS network.) Thus, some of the important design and development documents have been created under the IMTMS project as noted in the remarks section in Exhibit 11.

Exhibit 11 –List of Deliverable Documents Produced

Document	Delivery Date	Remarks
User Requirements – San Diego Regional Arterial Management System (RAMS), Final	November 1998	Produced by NET & BRW
User Requirements – San Diego Regional Arterial Management System (RAMS), Final	October 1999	Produced by NET & BRW
Concept of Operations – San Diego Regional Arterial Management System (RAMS), Draft	June 2004	Deliverable 122 of the IMTMS Project, Produced by NET
Baseline QN4 High Level Design Document	March 2003	Produced by BITran Systems
Tier 1 High Level Design Document	October 2003	Produced by BITran Systems

3.2 Impact of Showcase Integration on Project and Regional System Planning

3.2.1 Impact of RAMS on other Showcase Projects

The RAMS project has had three primary impacts on other Showcase projects, including the continued development of the RIWS, proof of the “Design Once, Deploy Many Times” concept, and integration assistance for the IMTMS network.

- The RAMS project and funding enables the continuation of the development of the RIWS initiated through the MVEM project. Tier 1 will develop the agency-to-agency interfaces. Tier 2 of the RAMS project will upgrade the RIWS capabilities.
- As with other predecessor Showcase funded projects in the San Diego region, RAMS continues to be a microcosm of the Design Once Deploy Many Times concept originally envisioned for the Southern California Priority Corridor transportation systems. It achieves economies of scale through the procurement of regional software licensing, and coordinated software installation, maintenance and upgrade.
- Integration of agencies with the regional IMTMS network is kept as a priority through the interest of individual agencies in projects such as RAMS. While RAMS is focused primarily on traffic signal controls, its relationship with the ATMSi and IMTMS projects helps to maintain regional awareness.

3.2.2 Impact of other Showcase Projects on RAMS

Other Showcase projects have had the helped to develop network and network security services for RAMS and other regional projects, based on XML and web service based tools.

- The QuicNet/4+ system will be built on XML and web service based tools. However, the San Diego region has adopted an overall ITS deployment plan that accommodates on-going Showcase-based CORBA deployments, as well as setting the groundwork to take full advantage of the emerging XML and web services based tools. The Mission Valley ATMIS project will use a CORBA- based protocol and Showcase-based architecture to serve the planned CORBA clients. RAMS will accommodate the integration of Showcase based architecture projects while leading the migration to XML and web services.

4 Cost Evaluation

The cost evaluation draws information from documented costs and personal interviews. This cost evaluation is based on project budget information for the RAMS project to date and was derived directly from the project's contracts and amendments. Informal interviews were conducted to verify and supplement information as needed during analysis.

4.1 Constraints & Assumptions

This cost evaluation is based on costs as reported by the project and contract managers. The contract costs indicate the current value of the contract including any amendments. The RAMS project was let as a Task Order contract.

4.2 Project Budget & Estimated Development Costs

4.2.1 Project Budget

The RAMS project is being conducted as a task order contract for \$1,000,000 and is funded through a grant derived from federal, state, and local sources

The RAMS Project is funded through the Priority Corridor Showcase Program under the Signal Integration Grant. Grant funding sources and project component allocations are shown in Exhibit 12.

Exhibit 12 – Funding Sources and Allocations for the RAMS Project

Fund Sources	Amount
CMAQ	\$250,000
SANDAG (FSP)	\$257,000
SCPC Showcase Program	\$1,100,000
Caltrans Research & Innovation	\$18,000
Total	\$1,625,000
Project Components	
Develop and Deploy	\$1,100,000
IMTMS Integration	\$300,000
SANDAG Oversight	\$125,000
Communication Costs	\$100,000
Total	\$1,625,000

RAMS Tier 1 contract was issued out of the above funds as a Task Order contract. The contract budget is illustrated in the following table in Exhibit 13.

Exhibit 13 – Total Budgets of the RAMS Contract(s)

Contract	Contractor	Contract Current Value	Percentage
RAMS Tier 1 Contract	BITran - McCain	\$1,000,000	100%
		\$1,000,000	100%

RAMS project management provided a breakdown of budget items according to task or groups of tasks. Some task items do not have distinguishable budgets, but are combined together as a group. The current budget distributions for each of the project tasks are shown in Exhibit 14.

Exhibit 14 – RAMS Tier 1 Budget per Task

Task	Cost Item	Current Budget	Current %
1.1	Establish QuicNet 4+ High Level Design	\$28,000	3%
1.2	Final Design and Functional Requirements		
1.3	Phase 1 System Deployment – Security Features	\$321,000	32%
1.4	Phase 2 System Deployment – Monitoring Capabilities	\$160,000	16%
1.5	Phase 3 System Deployment – Corridor Timing Plans	\$166,000	17%
1.6	Phase 4 System Deployment – Center to Center Interface	\$269,000	27%
1.7	Final System Deployment of Tier 1 – Expansion to All Agencies		
1.8	Training and Documentation		
1.9	Maintenance, Support and License	\$54,999	5%
	Total	\$998,999	100%

4.2.2 Design Once, Deploy Many Times

The RAMS project will follow the lead of other regional projects (such as MVEM) in demonstrating the SCPC Showcase concept of “Design Once, Deploy Many Times.”

An important aspect of the RAMS project is its vital role in the enhancement and expanded deployment of the regional integrated workstation. This project will be the second project in the San Diego area to deploy the workstations that are planned for use throughout the region as part of the regional network. This workstation, as designed and prototyped in the MVEM project, will be deployed in other cities and agencies throughout the region to support additional traffic management activities such as shared traffic signal information and control. In addition to the

City of San Diego and Caltrans District 11, the City of Chula Vista will be the next in line for the workstation deployment.

Those agencies not receiving a full RIWS, will receive a QuicNet/4+ client workstation that will provide access to the QuicNet/4+ regional network and neighboring jurisdiction traffic signal system information. Like the RIWS, the QuicNet/4+ client workstation will be duplicated from agency to agency in order to garner the cost savings and benefits of the design once, deploy many times concept.

The widespread deployment of the QuicNet/4+ system across the region is largely due to the cooperative decision among the region's cities and transportation management agencies to choose a single COTS package for common use in managing their traffic signal control systems. Many of the agencies in the region had some form of the QuicNet software prior to participating in the RAMS project. This allowed project partners to participate in the acquisition of a regional license for QuicNet product upgrades and customized version for the purposes of the RAMS.

5 Institutional Impacts Evaluation

5.1 *Impacts to Operations and Maintenance Policies and Procedures*

The RAMS project has developed San Diego's first region-wide cross-jurisdictional signal control system agreements.

The concept of operations for the RAMS project was developed cooperatively by the participating local agencies through what is now known as the Traffic Systems Technical Working Group. The group developed the user requirements for the user interfaces and system functions based on their collective experience with traffic signal control systems and the QuicNet/4 software and its predecessors. A set of policies, procedures and protocols have been developed that provide direction for security and shared operation of the field devices and systems connected to the regional network; these are reflected in the deliverable documentation produced by the contractors responsible for the development of the RAMS system architecture: User Requirements, Concept of Operations and Implementation Plan. (See Endnotes and References Section for complete document reference information)

5.2 *Impacts to Staffing/Skill Levels and Training*

Time and effort invested by RAMS project participants has added considerable and unquantifiable value to the project.

An extremely important contribution of high value, which cannot be easily assessed in terms of its cost, is the participation of the many local agencies and their representatives in the RAMS project. Project participants have invested significant amounts of time to-date in the project development. It is anticipated that there will be continued involvement by these same project participants in on-going development, testing, and eventual operation of RAMS. The project participants have and will continue to review materials and software builds, participate in installation and testing, and establish and refine operating procedures and guidelines for the region. Without their commitment to the project vision, and investment of their time, this project would not have been possible.

It must be noted that the RAMS project is the genesis of the QuicNet/4 Users Group. Thus the interest in the project was driven by agencies that were brought together to resolve traffic signal system management issues that would not otherwise have been discussed.

RAMS has not been deployed and therefore any additional impacts to local agencies with regard to staffing, skill levels, and training cannot be assessed at this time. Training for participating agency personnel is planned to be conducted by the system developer as each agency system is installed. Installations will take place in groups, and training sessions will be planned to accommodate agency personnel in each group.

5.3 Impacts to the Competitive Environment

RAMS QuicNet/4+ software is proprietary; developed and distributed only by BITran Systems.

QuicNet/4+ software is an upgraded and customized version of a software application developed and distributed only by BITran Systems for the San Diego region and the RAMS project. There are no alternative vendors for this product, thus highlighting the importance of maintaining a positive working relationship with the product vendor, careful monitoring of the vendor's business status, and incorporation of an extended maintenance and support contract.

5.4 Impacts to Local Planning Processes, Policy Development, and the Mainstreaming of ITS

RAMS regional software licensing permits an economy of scale for local agencies participating in the project.

A regional license for the QuicNet/4+ upgrade software will be held by SANDAG on behalf of the participating local agencies within the boundaries of the County of San Diego. The agency will be eligible for this QuicNet/4+ license under the assumption that it currently owns a license for one of the predecessor QuicNet/4 products.

SANDAG will be responsible for the management, distribution, and administration of the licenses and software, including tracking the agencies to which the license and software has been distributed. The license will not include source code rights to the QuicNet/4 products.

RAMS Tier 1 tasking also includes the arrangement of other regional licensing that will benefit all project participants. The QuicNet/4+ Seed/Legacy Bridge Software will be developed separately from the individual workstation software and will require a separate software license. Network software, expected to be a COTS product, will be required to connect to the IMTMS network. Finally, each RAMS workstation, server, or computer will require operating system and support software. This software is also expected to be primarily COTS products and will be subject to the licensing agreements of the vendor at time of purchase. Licenses for the QuicNet/4+ Seed/Legacy Bridge Software, network software, operating system and support software, will also be managed and owned by SANDAG on behalf of the agencies in San Diego County.

One of the main benefits of the regional licensing schema is the development of a regional standard that is maintained across all of the agencies in San Diego County. Independent upgrade of transportation management system software is not required. The region will conduct upgrades as a group to continue to benefit from the economy of scale and to maintain the essential interoperability required by the system.

6 Traveler and Transportation Information Management Evaluation

The RAMS project continues the regional vision of cross-jurisdictional management of traffic and transportation systems, field devices, and infrastructure. The RAMS project did not progress past the planning and design phases during the period of the evaluation, therefore a full evaluation of RAMS traveler and transportation information management was not possible; however, significant lessons learned from the coordinated, multi-agency planning and design efforts. Sections 1-4 of this document describe some of the lessons learned and discuss findings based on anecdotal evidence collected through interviews with project partners.

Some expected future benefits of RAMS include:

- The ability of signal status information to come back through the QuicNet/4+ network providing operators with current status from the transportation management center versus the field.
- The ability of the system to provide information about the currently implemented timing plans.
- Improvements in the ability to implement regional timing plans for events, incidents and specific time-of-day congestion.

7 Transportation System Impacts Evaluation

The RAMS project is expected to enhance and promote the concept of a common system for sharing, display, and control of transportation system field devices in the San Diego region. Tier 1 of the RAMS project is intended to provide the additional enhancements of the multi-agency network of transportation management systems through the development of the QuicNet/4+ traffic signal control system. This development will provide a foundation for the continued upgrade of the RIWS and set up the policies, planning, design, and network to enable the expansion of the RIWS to additional agencies throughout the region.

An evaluation of RAMS transportation system impacts was not possible during the period of the evaluation, however, there are significant lessons learned from the coordinated, multi-agency planning and design efforts. Sections 1-4 of this document describe some of the lessons learned and discuss findings based on anecdotal evidence collected through interviews with project partners.

Some additional future system impacts of RAMS expected by the project partners include:

- Inter-jurisdictional signal control where there was none, providing for improved traffic flows across the regions main arterials.
- Quicker response to signal system faults through better communication between agencies on the common QuicNet/4+ network.
- The potential for improved signal timing management within agencies based on the use of best practices shared between agencies in the region.

Conclusions and Recommendations

The deployment of the RAMS project has experienced numerous delays that have prevented the system from reaching deployment during the period of the evaluation. Although the project has completed only the design and policy development tasks, important lessons learned from these tasks are discussed in this document for the benefit of similar future development efforts. Therefore, this document contains information and lessons learned relative cost, system planning and design, project schedule, and the influence the Showcase Program integration on the project and regional planning. Expected future benefits of the project, as indicated by project management and project partners, are included in the sections on transportation and traveler information and transportation system impacts. Project delays were primarily attributable to difficulty moving the project forward from planning to deployment, and vendor project management issues.

The RAMS project's primary impacts on other Showcase projects include the continued development of the RIWS, proof of the "Design Once, Deploy Many Times" concept, and integration assistance for the IMTMS network. Other Showcase projects have had the helped to develop network and network security services for RAMS and other regional projects, based on XML and web service based tools.

The RAMS project will be conducted as a task order contract for \$1,000,000 and was funded through a grant derived from federal, state, and local sources. The project is currently well under budget, but is faced with time constraints due to the above discussed delays. The vendor contract expires in September 2006.

The RAMS project will follow the lead of other regional projects (such as MVEM) in demonstrating the SCPC Showcase concept of design once, deploy many times. Additionally, the RAMS project has developed San Diego's first region-wide cross-jurisdictional signal control system agreements. The success to date of the consensus on the design of the system can be attributed to time and effort invested by RAMS project participants, which has added considerable and unquantifiable value to the project.

While the RAMS QuicNet/4+ software is proprietary; developed and distributed only by BITran Systems, agreement by project partners to use this software regionally has permitted regional software licensing permits and produced an economy of scale for local agencies participating in the project. The region may consider an arrangement with product vendor to provide encrypted source code as back-up for future application upgrades should vendor have financial or management difficulties. Overall the project has great potential and will benefit from recent tighter project management controls instituted by the system developer.

Based on lessons learned from the RAMS project, mitigation of delays that inhibit project progress may include the following:

- Adoption of a project management standard that includes a structured deliverable document review process. The outcome would be more efficient and expedited deliverable document review cycles.
- Proper work load adjustments for public agency staff responsible for technology project management. Adoption of a project management standard would also allow more accurate estimates of time required to monitor and manage a technology project.
- Agencies must allocate time for project managers to attain an appropriate level of technical expertise with regard to their project's systems, software, or hardware. Alternatively, agencies could provide the project managers with appropriate support staff that have the applicable technical expertise to support the management of projects of this type. Historically, project managers have not had enough time to come up to speed on their project technologies in addition to conducting their regular project management tasks and deliverable reviews.
- RAMS is a good example of a project that has included the involvement of operations staff throughout the planning and design phases of the project. Operations staff must be included throughout the system development life cycle to ensure system suitability, shorten review cycles, and reduce the potential need for re-engineering system components or redefining system functionality.
- Consensus building, procedure development, and policy formation, are time consuming factors in the design, development, and deployment of regional projects that include multiple agencies and jurisdictions. Subsequent projects in the San Diego will benefit from the regional architecture completion. Groundbreaking consensus building has already occurred with this project, IMTMC/S, Mission Valley Event Management (MVEM), and others. Few previous precedents or models were available for projects of these types; now that the San Diego area has regional, cross-jurisdictional projects that have undertaken these challenges, the policies, procedures, and consensus-building lessons learned should be reemployed in future projects.

Appendix A – RAMS Interview Guide

Measure 1.1.1 (The System Development Process)

BITran/SANDAG

1. When did the RAMS project kick-off?
2. Was a Concept of Operations (ConOps) developed during the project? If so, at what point, and who was involved in its development?
3. What other deliverables were developed and on what date was each one finalized?

Measure 1.2.1 (NA)

Measure 1.2.2 (NA)

Measure 1.2.3 (Compatibility)

BITran/SANDAG

1. Have there been any indications of interference or incompatibility between your legacy system(s) and the RAMS system?

Measure 1.2.4 (Scalability)

BITran (system developer)

1. Please describe the system's architecture – both software and network design.
2. How many additional affiliates can the system support?

Measure 1.3.1 (Impact of Showcase Integration on Individual Projects)

SANDAG

1. What was the RAMS's originally contracted period-of-performance (POP)?
2. To what extent did integration with the Kernel or other Showcase projects impact the RAMS's design and/or schedule?
3. Did your agency procure any hardware or software for the Showcase Program on behalf of the Priority Corridor? If so, please list the items and their estimated costs. Also indicate if these are one-time costs or ongoing (monthly) costs.
4. Were there any other unplanned hardware/software/enabling technology purchases or upgrades that resulted from Showcase? (For example, required yet unexpected upgrades to databases, radios or other systems). Please list them.
5. Were there any other unusual technical issues or concerns created by Showcase that impacted your project? If so, what actions did you take to deal with them?
6. Were there any institutional issues, preferences or concerns created by Showcase that impacted your project?
7. What were the most important lessons learned from the RAMS project?

Measure 2.1.1 (“Design Once, Deploy Many Times”)

SANDAG

1. Do you feel that “Design once; deploy many times” has been achieved? Why or why not?

Measure 2.2.1 (O&M costs (labor, utilities, space, etc.))

SANDAG

1. Who sets the agency’s O&M budget, and what is the procedure for requesting a budget change (i.e., for getting a new system included into the annual O&M budget)?
2. Please estimate or provide the documented monthly totals associated with each of the following:
 - a) labor hours for technicians to operate/maintain the RAMS system.
 - b) electric utility costs associated with operating RAMS.
 - c) telecommunications costs associated with operating RAMS.
 - d) cost of office space that RAMS equipment occupies.
 - e) labor hours spent on maintenance of the RAMS system.
 - f) cost of replacement hardware/software associated with maintenance activity.
 - g) ongoing costs for software licenses.

Measure 3.1.1 (Changes in O&M procedures/policies)

SANDAG/BITran

1. Did your agency change any of its policies or procedures as a result of the RAMS?

2. Operations

- a) Have you discontinued any tasks or activities that you used to perform because of the RAMS?
- b) Has the RAMS impacted how you deal, communicate or coordinate with other agencies (such as local traffic departments, transit providers, law enforcement, media, ISPs, etc.)?
- c) Has the RAMS impacted how other agencies (such as local traffic departments, transit providers, law enforcement, media, ISPs, etc.) deal, communicate or coordinate with you?

3. Maintenance

- a) For how much of the RAMS system are your maintenance staff responsible (workstation hardware/telecommunications connection/software)?
- b) Did your maintenance staff require any special hardware or software training for RAMS?
- c) Did the RAMS system replace any legacy systems that you no longer need to maintain?

Measure 3.2.1 (Staff changes)

SANDAG/Local Agencies

1. Were any staff hired (either directly or under contract), fired, or reassigned as a result of the RAMS? If so, how many?

Measure 3.2.2 (Number of hours of staff training)

See Measure 4.2.1

Measure 3.2.3 (Job classifications created/deleted)

SANDAG/Local Agencies

1. Has RAMS impacted the job titles, responsibilities and/or pay of any of your operations staff members?

Measure 3.2.4 (Change in employee turnover rate)

SANDAG/Local Agencies

1. Has the RAMS system affected your employee turnover rate?

Measure 3.3.1 (NA)

Measure 3.3.2 (Number of ITS standards implemented)

BITran

1. Were any ITS standards implemented in the RAMS system?

Measure 3.4.1 (Number of agencies involved in transportation & traveler information management)

SANDAG/BITran

1. How many agencies generate, manage, and/or exchange data using the RAMS system?

Measure 3.5.1 (Impact of Showcase on local planning)

SANDAG/Local Agencies

1. Was an RAMS-like system (it may not have been called by this name at the time) originally called for in the Regional Transportation Plan? If not, has it been added to the plan? Explain.
2. Has either support or expansion of RAMS been included into state or local improvement plans?
3. As far as you are aware, have any other public plans been modified as a result of either the RAMS or Showcase? Explain.
4. As far as you are aware, has the execution of any other plans been temporarily or permanently postponed as a result of either the RAMS or Showcase? Explain.
5. Has an effort been made to inform other planners and policy makers - who may not know about RAMS or Showcase - about the projects? Explain.
6. Did you forego any other transportation improvements in order to fund your agency's involvement in either the RAMS or Showcase? Explain.
7. Was equipment was installed at your agency as a result of the RAMS/Showcase? If so, is there anyone at your agency who is responsible for maintaining an inventory or architecture of that installation?
8. Were any policies (such as procurement policies, business plans, operations policies, etc.) within your organization enacted, revised or dropped as a result of either the RAMS or Showcase?

Measure 3.5.2 (Impact of both public and private sector policy decisions on Showcase projects)

SANDAG/Local Agencies

1. Who sets the policy with regard to RAMS and/or other transportation management and information systems?
2. Are there, or have there been, any policy decisions that affect the use, marketing, operation, maintenance, or expandability of RAMS?

Measure 4.1.1 (Change in number of information exchanges (quantity))

SANDAG/Local Agencies

1. Have there been any new information or data exchange capabilities enabled through the implementation of the RAMS system? Has there been a change in the volume of information or data exchanged through existing capabilities between participating agencies or the public?

Measure 4.1.2 (Change in communications quality (timeliness and quality of data exchanged))

SANDAG/Local Agencies

1. For those ISPs that share their own data with the public sector, would you say that their data is of better quality, about the same, or of lesser quality than what the public sector collects? Please explain.

Measure 4.1.3 (Number of new ITS system architecture data flows implemented)

Measure 4.2.1 (Change in agency performance as a result of Showcase)

SANDAG/Local Agencies

1. How much money do you estimate you save through the use of the RAMS system? Are there other efficiencies or performance enhancements that you have gained through the use of the RAMS system? Please explain.
2. Can you share any examples of favorable or unfavorable feedback from patrons or system operators regarding the systems and devices implemented through RAMS?

Measure 4.3.1 (NA)

Measure 4.3.2 (NA)

Measure 5.1.1 (NA)

Measure 5.1.2 (NA)

Measure 5.2.1 (NA)

Measure 5.2.2 (NA)

Measure 5.3.1 (NA)

Measure 5.3.2 (NA)

Measure 5.3.3 (NA)

Measure 5.4.1 (NA)

Measure 5.5.1 (NA)

Measure 5.5.2 (Change in transit agency's operational efficiency)

Local Agencies

1. Do you feel that RAMS has helped boost ridership?

Measure 5.5.3 (Change in select operating costs)

Local Agencies

1. Has the RAMS helped you save money on operations?

Measure 5.5.4 (Number of staffing changes required)

See Measures 3.2.1, 3.2.3, 3.2.4

Measure 5.6.1 (NA)

Endnotes and References

ENDNOTES

¹ ISTEA requires that “operational tests utilizing federal funds have a written evaluation of the Intelligent Vehicle Highway Systems technologies investigated and the results of the investigation.” Although Showcase is not officially an operational test, it deploys and demonstrates ITS services, functions, and technologies under “real world” conditions, similar to an operational test.

² California Statistical Abstract, Table B-4. California Department of Finance, Sacramento, CA. December 2003.

³ California Statistical Abstract, Table J-4. California Department of Finance, Sacramento, CA. December 2003.

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